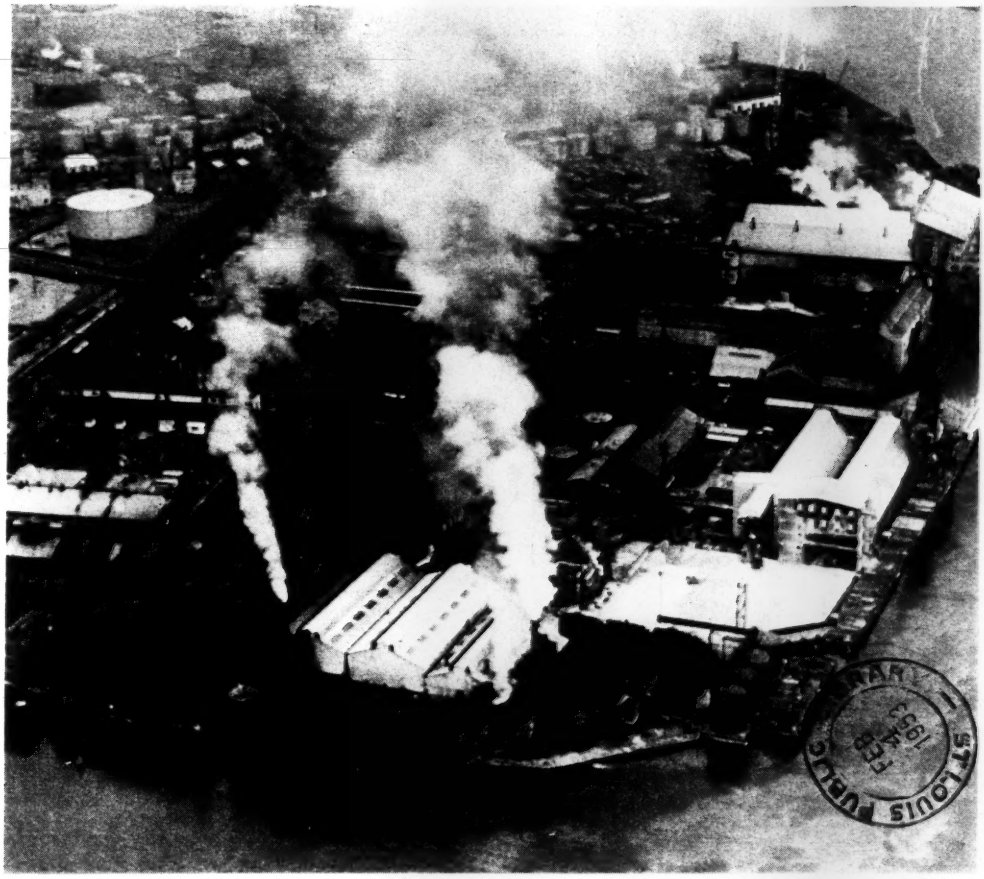
# Air Repair

Vol. 3, No. 3 February, 1953




Checking air pollution violations via helicopter pays off in New York City, whose area of 340 sq. mi. can thus be covered in less than two hours.

AIR POLLUTION CONTROL ASSOCIATION
4400 FIFTH AVENUE PITTSBURGH 13, PA.

Founded 1907

# Air Repair

A QUARTERLY JOURNAL DEVOTED TO AIR PURIFICATION



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The Editor welcomes writers interested in Air Pollution problems and encourages them to use the pages of this magazine for the expression of their opinions. But neither he nor the Association assumes responsibility for the validity of these opinions.

# Highway Traffic Contributions to Air Pollution

by L. J. GRUNDER, *Chief Products Research Engineer*
Richfield Oil Corporation
Los Angeles, Calif.

*Condensed from an address delivered before the Institute on Atmospheric Purification, Biltmore Hotel, Los Angeles, California, October 24, 1952.*

THE APPROXIMATELY 2,000,000 vehicles in Los Angeles County are driven an average of 50,000,000 miles per day, and this driving consists essentially of 1) idling while standing still; 2) accelerating—either from a stop or from one speed to a higher speed; 3) cruising at essentially constant speed; and 4) decelerating—from a higher to a lower speed.

When reference is made to smog which contains "hydrocarbons," one ordinarily thinks of them as being combustible. Inspections of exhaust gases collected under widely different driving conditions show that gases which can be burned come out of the tail pipe only under decelerating conditions. You cannot ignite and burn either an idling mixture tail pipe gas or a cruising mixture or an accelerating mixture exhaust gas.

## Autos All Alike

Everyone will agree that there is little fundamental difference in the mechanical parts of automobiles—they may differ in arrangement of their many parts, but all have pistons, valves, spark plugs, combustion chambers, carburetors, intake manifolds, and exhaust manifolds. Each of these things are in contact with the fuel mixture fleetingly as the fuel passes through the engine.

Two major driving influences have been at work in changing the job that the engine has to do. These are: 1) faster highways and freeways and also slower city traffic, and 2) an increasing number of convenience items on the newer cars, such as automatic transmissions and hydraulic power assists.

The American car has been growing in size, weight and luxury items until it has permitted the influx of foreign cars to take over the position of the long-gone "cheap" transportation American automobile. Turnpikes and freeways have stimulated interest in higher speeds and greater horsepower.

## Too Complicated

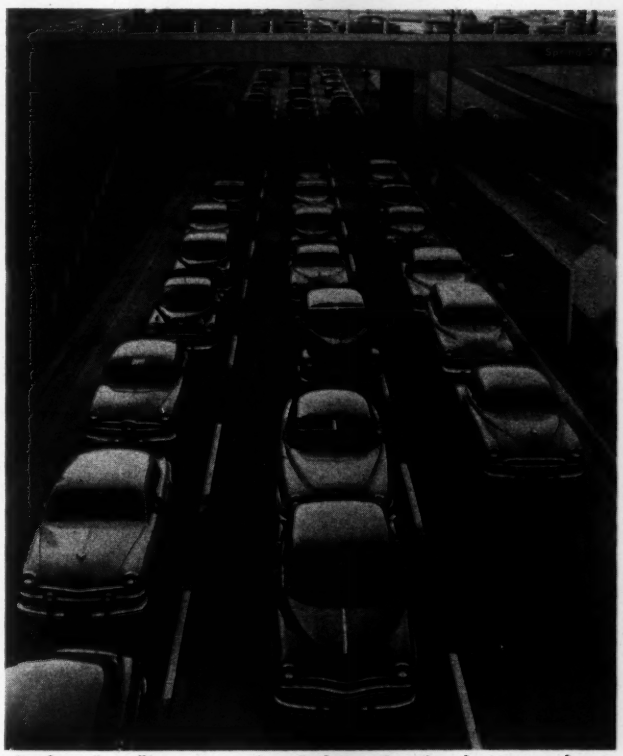
Power is the present goal of the designer, and when an owner lifts the hood after a year's ownership, he will do well to identify half the complicated devices that are in view.

Maintenance is a major factor in the life of a car, yet many cars are not maintained properly because it has become too complex for the handy-man owner, and it is becoming too expensive too often for the owner who relies entirely upon service garages. A few days ago I received the shop manual for a well-known car, and it was the size of the Los Angeles telephone book. Let's face it—as cars become more intricate, more cars will be operated out of adjustment, and the chances for greater air pollution will increase.

Engine exhaust purity is relative.

*One man with bad breath in a packed elevator is a marked individual, but out in the open he is unnoticed.*

Everyone believes his car doesn't stink, but if it did, then it must either be the fault of the engine design or the fuel. He never is convinced that somehow he himself is the greatest contributing factor due to failure to appreciate the need for good maintenance when the engine requires it.



*Eastbound traffic on Santa Ana Parkway, Los Angeles, approaching the east terminus between Los Angeles and San Pedro Streets. Photo courtesy Los Angeles Department of Traffic Engineering.*

Engines, when operating, either produce power or absorb power. Gasoline burns and produces the pressure to push the pistons down even when the engine idles slowly at the curb, but each year we note that more auxiliary equipment is hung on the engine for it to turn for the enjoyment and convenience of the driver and passengers.

Take the electric generator which is getting larger each year because of the radio, electric window lifters, electric front seat adjusters, electric top raisers, electric cigarette lighters, spot lights, head lights, tail lights, turn signals, stop lights, map lights, trunk lights, dome lights, underseat heaters, defrosters, car heaters, license plate lights, under-hood lights, electric horns, ignition system, and many more power-consuming devices. It takes extra gasoline also to run that 1952 hydraulic power steering gear and in 1953 an air cooling system.

## Power Needed

Then there is the water pump or pumps driven by a v-belt, which takes more power than ever before because the smaller amount of water must be circulated faster through the smaller radiator and must cool the automatic transmission fluid as well as the engine block.

Further, there is the radiator fan which must turn fast enough to cool the engine when idling on a hot day or when there is a tail wind. If that were not enough for the small amount of idling fuel to handle, the torque converter units are now a part of the flywheel, and the oil in them is churned as the engine idles, and in some cars there are fins attached to the outer surface which rotate with the torque converter body, and this fan action cooling requires additional power.

A simple pre-war car could idle at the curb for 180 minutes on one gallon of gasoline, but the modern more complicated car can run at best only some 150 minutes per gallon, due entirely to the fact that there is more work for the gasoline to do.

Go back to my statement of an engine "absorbing" power. If in downtown city traffic you "go" with the signal, and 30 seconds later the next signal changes to "go," by averaging 17 miles per hour you will be able to make each signal.

However, you may decide to "gun" the throttle and reach 40 mph., and then let up and off the throttle and come to a stop by applying your brakes. From the time you let up on the throttle and come to a dead stop—you are absorbing power or producing "negative power." During this period, while the momentum of the car is rotating the engine, gasoline is being sucked into the engine at a rate up to three times that during idling, and your car would then drink a gallon of gasoline in from 50 to 60 minutes!

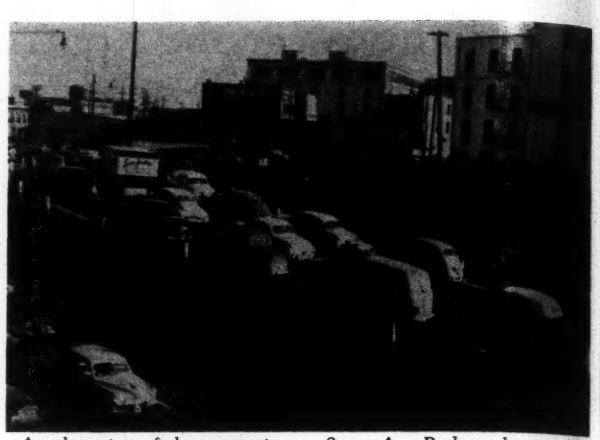
## Pressure Problems

Combustion of the fuel during deceleration is entirely different from combustion during idling conditions. During idling every spark plug ignites the rich but rare mixture of air and gasoline together with some residual gases retained from the previous combustion cycle. With your hand over the tail pipe, you can feel each impulse as each exhaust valve opens and a definite amount of warm gas comes out of the exhaust.

The pressure conditions during "negative power" or decelerating conditions are all sub-atmospheric. Here the momentum of the vehicle turns the engine at high speed while the throttle is closed, and the intake manifold maintains a vacuum of about 23 inches of mercury, which is the equivalent of a pressure altitude of 35,000 ft. Under these conditions, you cannot even keep a match or a cigarette lighter burning.

When the piston rises and attempts to compress the rarefied gas, it reaches a pressure altitude of 10,300 ft. at the moment of ignition, which is too rare in oxygen to cause a conflagration even though there is plenty of fuel present.

The non-ignited air and fuel mixture are further compressed up to top center, and then the piston drops suddenly, stretching the mixture and when the exhaust valve opens, the relatively high pressure (atmospheric) in the hot exhaust pipe shoots its rich hot gases back into the cylinder and they are first drawn in and then all forced back out into the exhaust pipe. This re-cycling of fuel-rich mixtures results in partial oxidation of hydrocarbons and these include the odoriferous "aldehydes" which everyone is familiar with.



*Another view of the congestion on Santa Ana Parkway between Los Angeles and San Pedro Streets. Photo courtesy Los Angeles Department of Traffic Engineering.*

## Bus Problems

In 1939, here in Los Angeles, my company carried out a very extensive research program on gasoline engines in bus service. From this lengthy work, several conclusions could be drawn:

1. Engine design is the major factor affecting gassing. The intake manifold system, compression ratio, displacement and exhaust system all have a definite and individual influence.
2. The mechanical condition of the engine and the adjustment of its accessories is an important factor.
3. Mechanical degassing devices can assist in eliminating "gassing," but mechanical maintenance was found to be excessive at that time.
4. The type of fuel used is not the major factor in the solution of the "gassing" problem from a fleet standpoint, although greater volatility does exert some influence in the reduction of obnoxious odors.

In the period since 1938, there has been up to now no recorded investigation of this deceleration cycle, which is, I believe, the greatest mass contributor to "hydrocarbons" in the atmosphere.

One reason for this is the lack of a good recording instrument which can respond to the very low cylinder pressures and high vacuums. Upon my recent request, the Ethyl Corporation Research Laboratories set up a new strain-gauge recorder. This is a real step forward in studying oxidation reactions in an engine.

## Some Gasoline Statistics

According to a recent report by engineers of the Los Angeles County Air Pollution Control District, some 3,850,000 gallons of gasoline are consumed each day. To this should be added some 58,000 gallons of lubricating oil which is also burned, oxidized, or lost.

In summarizing their report, they divide the different types of driving in Los Angeles County into four classifications: idling, acceleration, cruising, and deceleration.

Placing these figures on a chart, they find that roughly 46 percent of the total time a vehicle is driven under cruising, or light load conditions, and the balance of the time is divided about equally between idling, acceleration, and deceleration:

| Driving Condition | Idling | Acceleration | Cruising | Deceleration |
|---|---|---|---|---|
| Time driven % | 18 | 18 | 46 | 18 |
| Gasoline— gal. per hr. | 4.45 | 2.25 | 1.52 | 1.22 |
| Hydrogen Concentration mg/liter | 5.8 | 0.8 | 0.9 | 15.0 |
| Exhaust Flow cu. ft./min. | 14.2 | 56.0 | 28.4 | 30.2 |
| Hydrocarbons into Atmosphere: Units | 17 | 8 | 13 | 62 |

These data from a single typical passenger car support similar results we secured as previously reported, and point out clearly that substantial exhaust fume improvement will result from a reduction in the number of times vehicles have to be slowed to a stop.

Second in importance is the need for reducing idling time at innumerable traffic stops. Los Angeles is doing this very thing now in the building of freeways to handle large numbers of vehicles so that they can reach their destinations quickly and with a minimum amount of exhaust fume discharge.

## Three Exhausts?

If a car owner will look closely, he will find at least two "exhausts," and three on some cars. The extra "exhaust" is the crankcase ventilator which conducts hot oily vapors through a discharge tube under the car.

Where the compression rings are weak, high pressure hot combustion gases blow past the piston rings and between the piston and cylinder walls, escaping to the outside air mainly through a large crankcase ventilating tube.

This vapor is composed of chilled unburned or burned gases forced past the oily clearance spaces around the pistons and the hot oil spray in the crankcase allows this gas to carry high molecular weight oil vapor into the atmosphere.

The odor from this vapor is beyond description and is found mainly with engines whose owners have no concept of the need for an engine overhaul or new piston rings installed if the wear is not great. An engine with smoking crankcase ventilator is an offender of the worst type.

## Diesel Problems

Now let us consider the diesel bus which employs a blower scavenged two-stroke cycle diesel engine with a torque converter drive to the wheels. This engine uses a high cetane, high-speed automotive virgin diesel fuel resembling water-white kerosene.

When the engine is first started, the maximum fuel rate is automatically established, otherwise the engine will not start.

*Westbound traffic on Aliso Street, Los Angeles, approaching Almeda Street on Ramp to Santa Ana Freeway. Photo courtesy Los Angeles Department of Traffic Engineering.*

This creates a large puff of black smoke. Whenever the vehicle is started into motion from a stop, the driver puts the accelerator pedal to the floor and the engine immediately speeds up to the maximum speed allowed by the governor, delivering power which is then multiplied in the fluid torque converter so that the bus quickly gets up to cruising speed, after which the driver takes his foot off the accelerator momentarily which results in an automatic change into direct mechanical drive.

On slowing down to a stop, the engine is being turned by the momentum of the bus, and characteristic odors emanate from the tail pipe. This combination of type of transmission and engine and city operation produces fumes and odors which are typical wherever this type of economical transportation is used.

The fuel is of premium quality, which leaves engine and fuel injector maintenance and lubrication oil selection as the major possibilities for exhaust gas quality improvement.

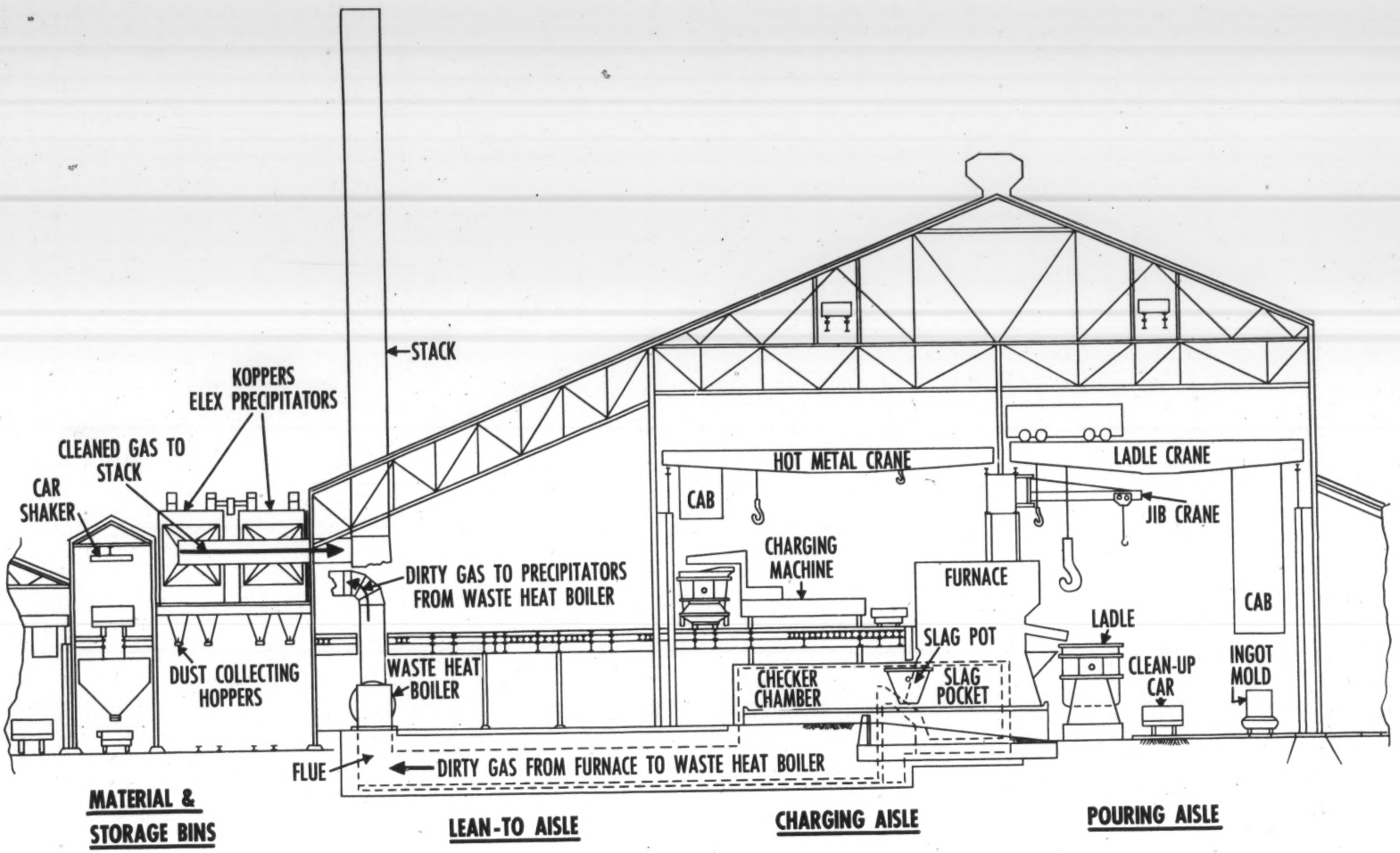
The large highway diesel transport trucks generally use a large six-cylinder, four-stroke cycle engine, either supercharged or unsupercharged, and burn the next heavier diesel fuel than do the city buses.

Lighter grades of diesel fuels result in reduced horsepower, higher fuel consumption, and more injector trouble due to reduced lubricating value.

When these engines are in good adjustment, there is very little visible smoke or fumes and hardly any noticeable odor. The diesel is an engine that depends upon excess air to burn its fuel completely and in general, nearly all fuels burned by diesels in this area are virgin stocks which burn quickly and cleanly.

Los Angeles drivers feel that the bus exhaust is more noticeable because its exhaust points horizontally to the rear at about a foot off the ground, so that cars with grille ventilator openings scoop the odors right up off the pavement.

On large diesel trucks, the exhaust stack usually points directly upward where the gas mixes with large volumes of air before it comes back down to the ground. The large diesel truck discharges very little objectionable gas unless it is in poor mechanical condition or improperly adjusted, and practically none bypasses the pistons into the crankcase.




## FURNACE BUILDING

*Cross sectional view of furnace building showing how Koppers Elex precipitators are installed at Morrisville. Note how cleaned gas is moved to stack. Dust collecting hoppers are located beneath precipitators.*

# Smoke Eaters For Nine Fiery Furnaces

*From the Autumn, 1952 issue of the Koppers Magazine.*

BLAST FURNACES are displacing beets and open hearth furnaces are sprouting where cabbages once grew on 1,400 acres of fertile flatlands along the Delaware River near Morrisville, Pa.

Here U. S. Steel's giant new Fairless Works—one of the largest single expansions of steel producing capacity undertaken—is rising rapidly, readying itself to become a new citadel of America's industrial might.

To the natives of Morrisville . . . and to the nation . . . the new $450,000,000 plant is nothing less than fantastic. Bigness is characteristic of the steel industry but this completely integrated steel plant is bigger and better and a marvel of modernity.

Into it are being poured the inventive and creative genius of U. S. Steel and its thousands of suppliers and the most advanced equipment that research scientists, engineers and designers can devise.

Some day during 1953 each coke oven, blast furnace, open hearth, mill and finishing room will be turning out its products. Annual capacity will be 1.8 million tons of steel ingots and a wide range of finished steel products.

Prosperity will have come to Morrisville . . . a new Morrisville that is a far cry from the sleepy village of two years ago with its acres of verdant truck gardens.

But to the trained eye of any veteran steel-mill man, something will be missing.

Not that anyone will be disappointed, but the nine spanking-new open hearth furnaces built by the Freyn Department, Engineering and Construction Division of Koppers Company, Inc., won't be belching smoke from their nine stacks.

For the first time in eastern United States and the second time in the world, the open hearths will be equipped with electrostatic precipitators which treat the furnace smoke electrically, causing the dust in it to be removed to collecting hoppers for disposal. A pair of them, made by Koppers Metal Products Division at Baltimore, will be installed at each of the nine furnaces.

The precipitators are being installed as integrated parts of the open hearth structure, and are located immediately beside, and in a line parallel to the furnaces, in the system of flues between the furnaces and their stacks or chimneys.

Each pair of precipitators will be about 48 feet long, 38 feet wide, and 38 feet high. The twin arrangement makes possible the by-passing of one of a pair for maintenance purposes.

Fairless plant's open hearth precipitator installation will be the largest anywhere. The precipitators are designed to remove more than 95 percent of the dust normally in open hearth exhausts.

While the principles of electrostatic precipitation have been known for many years, new applications are regularly being developed, and the Koppers installation at Morrisville is in a real sense pioneering. Creation of negative and positive electrical ions is the basis for the action of the precipitators. Smoke from the furnaces is channeled into the precipitators, where it passes a multitude of charged wires and plate electrodes and becomes ionized.

Solid particles in the stream of smoke are thus given electrical charges, and those charged negatively are drawn to the positive electrodes, while those charged positively are drawn to the negative electrodes. Periodic vibration of the collecting surfaces causes the collected dust to fall into hoppers from which it is removed for disposal.

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## CONTINUOUS RECORD FOR AIR POLLUTION CONTROL

by E. K. von Brand
Dobbs Ferry, N. Y.

FILTERING recorders employing a continuously, uninterruptedly moving tape for collecting fine particles can play an important part in the instrumentation for air pollution study.

This continuously filtering recorder was originated about six years ago at the Greenpoint Laboratories of the Socony-Vacuum Oil Company for investigating transient smoke phenomena at the start and stop of combustion periods in oil burners. Combustion work on all burners and engines is now done with tape speeds ranging from one inch per minute to one inch per second.

Qualitative and quantitative interpretation of the continuous-type record is made on the basis of concurrent use of other instruments, preferably over periods of equilibrium conditions.

The record may also be evaluated in connection with chart transcription by photo-electric, vacuum, etc., pick-ups with due regard to the properties of the sampled medium.

Important among the principles of design contributing to reliable operation of this recorder, and especially the reproductibility of results, are: conditioning of the tape with respect to humidity by means of a heated recording head and further improvement of tape surface uniformity by passage between the polished surfaces of the head.

The vacuum of from 4 in. to 8 in. of Hg at which the recorder is operated as a rule, tends to maintain a satisfactory seal between tape and recording fixture surfaces.

Experimental work on the use of treated tape for recording changes in the presence of gaseous contaminants such as $H_2S$, $SO_2$, CO, $CO_2$, etc., is making good progress, so that before long this recorder may fill the need for an inexpensive instrument for this type of analysis. The record in this case is interpreted on a colorimetric basis, in the simplest manner by comparison with a standard color chart.

# Industrial Experience in Fly Ash Collection

by B. S. NORLING
E. I. du Pont de Nemours & Company, Inc.
Wilmington, Delaware

*Contributed by the Fuels & Power Divisions and Air Pollution Controls Committee for presentation at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of The American Society of Mechanical Engineers.*

UNTIL RECENT YEARS, the atmosphere was considered a natural means of waste disposal. Almost without exception the furnace gases from homes, schools, small and large industries alike, discharged their furnace gases with all the products of combustion into the atmosphere.

With the increase in population and concentration of industry, this practice cannot be continued without deleterious effects. This paper discusses the problems involved, citing as an example the installation of fly-ash collectors and the disposal system for a large existing industrial plant.

The installation to be discussed was made in a plant that had a rather modest start in 1928. It was built approximately ten miles from the nearest city in a wooded valley apart from other industries and in a very sparsely settled area. At that time, little thought was given to a possible nuisance caused by fly ash.

The small amount of fly ash dispersed into the atmosphere during the early years of growth was not a nuisance. The plant did thrive and its growth was exceptionally rapid, reaching a size several times that of the initial installation. Immediately after the ending of World War II, a number of small industrial plants moved into the valley and the community became thickly settled.

A nice residential area was built and soon afterwards complaints were received from dust deposits. These complaints were investigated and found to be due, largely, to fly ash, and it was apparent that a clean-up program was in order. The development at this plant may be considered as typical of the industrial growth of many of the communities in the United States.

A survey was made to determine the plant's contribution to the conditions causing the nuisance. Tests were run to determine the fly ash emission rates from the power-house stacks. At the same time, the downwind concentration of fly ash at ground level was also measured. The fly ash concentration at ground level was found to be from 2 to 7 times in excess of values normally considered to be acceptable. The decision was then made to proceed with the installation of collectors.

## Plant Steam Generating Capacity

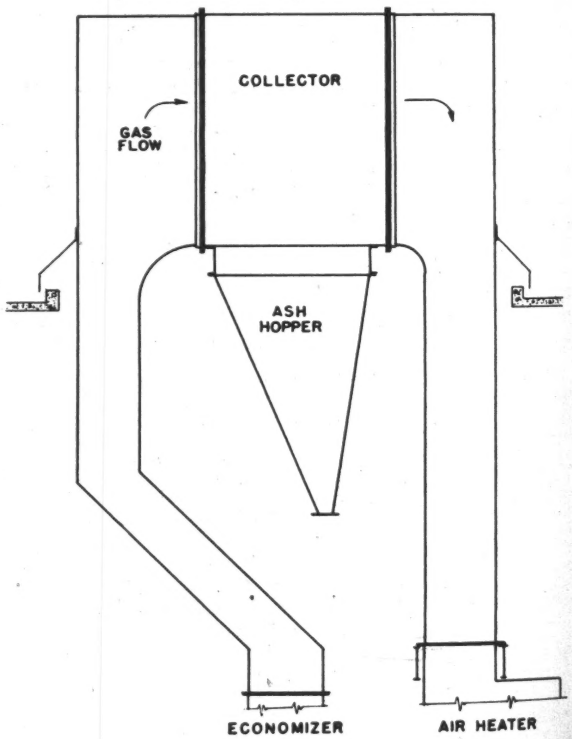
In the power house there are eight pulverized coal-fired boilers. Three of the boilers have a nominal steam-generating capacity of 80,000 lbs. per hour while the other five are rated at 130,000 lbs. The steam pressure is 450 psig with a total temperature of approximately 700° F. The peak steaming rate is 930,000 lbs. per hour and the average is approximately 750,000 lbs. per hour. This plant is in continuous operation and load variations are due to seasonal and production changes. The coal burned is obtained from a wide variety of mines from Virginia, West Virginia and Pennsylvania.

The ash content of the coal varies from 6% to 12% with the average around 9%. The average ash content has been slowly rising. Of the ash in the coal, approximately 15% drops into the furnace bottom or hoppers and the remaining 85% is carried through the boiler and out the stack as fly ash with the flue gas.

The carbon content of the fly ash varies quite widely. Because samples are taken at irregular intervals, a true average carbon content is not available. It has been estimated to be in the neighborhood of 20%. The carbon in the ash not only increases the quantity of fly ash, but it decreases the bulk density.

Random samples taken from the collector hopper indicate that the bulk density of the ash with 20% carbon varies between 30 and 35 lbs. per cubic foot when poured into a container as it does in a collector hopper. Tapping or shaking the container packs the ash and thus reduces the volume and increases the bulk density.

*Fig. 1. Cross section of collector installation.*



The designer can readily appreciate the effect on the collector hopper storage capacity when the ash content of the coal and the carbon content of the ash increases.

The design may have been based on the removal of the ash each eight-hour shift, but with an increase in ash and carbon content, the volume required increases rapidly and the hopper may have to be emptied at four-hour intervals.

## Selection of Collectors

There were numerous commercial collectors available from which to choose for this installation. The range in available collection efficiency approaches nearly complete removal of the last traces of ash, but, with the more thorough clean up comes a rapid rise in cost.

Another limitation was the space available, since no provisions had been made originally for the installation of collectors and this too increases the cost of the installation.

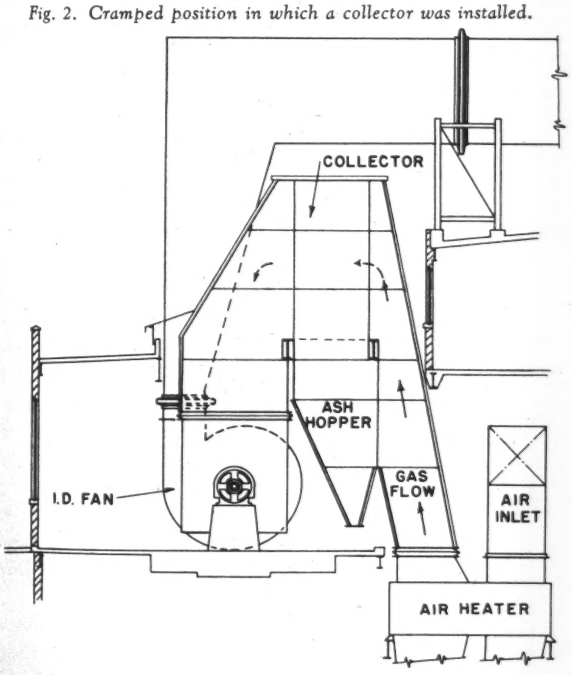
The question that naturally arises then is what collection efficiency is required? This is a difficult question. A heavy capital investment will cut deeply into the profitable operation of the plant since power costs must be included in the cost of the manufactured product with no assurance that the product sale price can be increased to cover the additional investment.

At present, the collected fly ash cannot be considered as salable. There will be some return through reduced induced draft-fan maintenance of the collector installation.

Thus, the installation of fly-ash collectors and the facilities for disposal become a costly burden on the operation of the plant. Nevertheless, abatement is a plant responsibility and good community relationship is the compensating return.

The selection of the type of collectors was made on the basis of the cost of the installation and the performance that was to be expected. A condensed summary of the results is shown in Table I.

*Fig. 2. Cramped position in which a collector was installed.*




ELEVATION

**Table 1—Fly Ash Collector Installation**

| | Mechanical Collectors | Electrostatic Precipitators |
|---|---|---|
| Steam Generation (Ave) #/hr. | 750,000 | 750,000 |
| Coal Burned #/hr. | 73,500 | 73,500 |
| Collector Efficiency % | 86 | 95 |
| Fly Ash Disch. to Atmos. #/hr. | 940 | 340 |
| Flue Gas—Dust Loading gr./c.f. @ 500° F. and 50% excess air | .25 | .09 |
| Installed Cost | $420,000 | $545,000 |

These figures are approximate costs estimated from preliminary information prior to the design and layout of the system. The figures do not include facilities for disposing of the fly ash as existing facilities were available.

The installation of electrostatic precipitators was especially difficult because of space limitations. The estimated increase in cost for the electrostatic precipitators over that of the mechanical collectors was $125,000.

The expected average reduction in fly-ash emission is 600 lbs. per hour. The incremental installation cost for the more thorough clean up is costly. There is a small reduction in cost of power consumption but not enough to justify the higher cost alone if the clean up is adequate with the mechanical collectors.

There were no local ordinances establishing the required collection efficiencies or limiting emission rates. Lacking any such mandatory regulation, the model ordinance suggested by the ASME was used as a guide for it is generally accepted and is one of the more stringent ordinances.

The ASME Code required that the dust loading of stack gases shall not exceed 0.25 gr./cu. ft. with the exception that a collector efficiency of not more than 85% is required for new plant installations and not more than 75% for plants constructed prior to the effective date of the ordinance.

The ordinance in the nearest city is far more lenient than the ASME Code. The atmospheric dust loading, at ground level downwind from the stack, was expected to be reduced to less than 0.55 grains per 1,000 cu. ft. as this figure is considered as acceptable in a normal city. Collectors with an average efficiency of 85% or better would then be expected to give the required clean up. On this basis, the mechanical collectors were accepted.

A mechanical collector does not give a clear gas leaving the stack. The very fine particles that remain give color to the gases; and, if there is a high carbon content in the particles, then the appearance of the discharge gases will be dark, even though the dust loading of the gas is light.

The color of the gases leaving the stack, though it was carefully considered, was not a determining factor. After the completion of the installation of collectors at this plant, a local civic organization voluntarily wrote a letter to the com-

pany expressing their appreciation and specifically stated that there was no longer a dust nuisance in the community.

TABLE II

FLY ASH COLLECTION TESTS

| Test No. | Units | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Steam Flow (Corrected) | #/hr. | 79,500 | 79,500 | 91,000 | 60,000 |
| Steam Temp. | ° F | 640 | 635 | 630 | 625 |
| Steam Press. | PSIG | 418 | 418 | 419 | 418 |
| F. W. Temp. | ° F | 255 | 255 | 255 | 255 |
| Gas Temp. at A. H. Outlet | ° F | 378 | 378 | 375 | |
| $CO_2$ - Boiler Outlet Recorder | % | 13.5 | 13.4 | 13.9 | 11.6 |
| Collector Press. Drop | In $H_2O$ | 2.5 | 2.5 | 2.85 | 1.75 |
| Inlet Duct Gas Temp. | ° F | 322 | 322 | 326 | 295 |
| Gas Flow at Duct Temp. (Pitot) | CFM | 41,500 | 41,500 | 45,400 | 32,900 |
| Sampling Time | Min. | 128 | 128 | 128 | 128 |
| Gas Sampled at Duct Temp. | Cu. Ft. | 1823 | 1824 | 1998 | 1458 |
| Ash Collected by Sampler | Grams | 239.2 | 248.4 | 287.2 | 158.1 |
| Dust Loading at Duct Temp.(Grains) | GR/CF | 2.02 | 2.10 | 2.22 | 1.67 |
| Outlet Duct Gas Temp. | ° F | 315 | 315 | 323 | 289 |
| Gas Flow at Duct Temp. (Pitot) | CFM | 44,400 | 44,400 | 48,700 | 34,900 |
| Sampling Time | Min. | 128 | 128 | 128 | 128 |
| Gas Sampled at Duct Temp. | Cu. Ft. | 1974 | 1966 | 2159 | 1540 |
| Ash Collected at Sampler | Grams | 32.6 | 37.6 | 34.0 | 28.7 |
| Dust Loading at Duct Temp.(Grains) | GR/CF | .255 | .295 | .243 | .287 |
| Hopper Catch | | | | | |
| Ash Caught During Test | Pounds | 1743 | 1654 | 1787 | 936.5 |
| Duration of Test | Min. | 180 | 170 | 150 | 160 |
| Ash Caught Per Minute | #/Min. | 9.7 | 9.74 | 11.91 | 5.86 |
| Ash Caught Per Hour | #/Hr. | 582 | 584 | 715 | 352 |
| Efficiency - Actual | | | | | |
| Inlet vs Outlet | % | 86.5 | 85.0 | 88.3 | 81.8 |
| Catch vs Outlet | % | 85.7 | 83.9 | 87.7 | 80.7 |
| Catch vs Inlet | % | 80.9 | 78.2 | 82.5 | 74.6 |
| Expected Efficiency | | | | | |
| Inlet Conditions | % | 90.4 | 86.0 | 89.95 | 83.75 |

Test Efficiency Based on #/Min of Dust

$$\text{Inlet Vs Outlet, Efficiency} = \frac{\text{Inlet-Outlet}}{\text{Inlet}} \times 100$$

$$\text{Catch Vs. Outlet, Efficiency} = \frac{\text{Catch}}{\text{Catch Outlet}} \times 100$$

$$\text{Catch Vs. Inlet, Efficiency} = \frac{\text{Catch}}{\text{Inlet}} \times 100$$

## Installation of Collectors

The collectors were designed and so arranged that the units could be put into serivce during the normal boiler overhaul period. There were eight collectors and the over-haul period extended from the first of April to the first of November.

The first unit was to be tested and if the performance was below that expected, corrections were to be made on the installations to follow. It was found possible to install the collectors in the allotted time and the performance of the collectors met the guarantee.

TABLE III

PARTICLE SIZE ANALYSIS

| Particle Size Microns | Test No. 1 Inlet % | Test No. 1 Outlet % | Test No. 1 Catch % | Test No. 2 Inlet % | Test No. 2 Outlet % | Test No. 2 Catch % |
|---|---|---|---|---|---|---|
| (-) 7.5 | 15.39 | 40.75 | 20.03 | 31.19 | 62.80 | 24.0 |
| 7.5 - 10.0 | 13.39 | 25.20 | 12.06 | 8.61 | 24.11 | 10.0 |
| 10.0 - 15.0 | 20.47 | 21.99 | 24.68 | 17.39 | 9.46 | 23.0 |
| 15.0 - 20.0 | 11.69 | 9.29 | 9.02 | 9.18 | 1.88 | 8.0 |
| 20.0 - 30.0 | 14.92 | 1.65 | 15.27 | 14.56 | 1.08 | 19.0 |
| (+) 30.0 | 24.14 | 1.12 | 18.94 | 19.07 | .67 | 16.0 |

| Particle Size Microns | Test No. 3 Inlet % | Test No. 3 Outlet % | Test No. 3 Catch % | Test No. 4 Inlet % | Test No. 4 Outlet % | Test No. 4 Catch % |
|---|---|---|---|---|---|---|
| (-) 7.5 | 20.44 | 72.79 | 19.0 | 32.19 | 71.26 | 22.0 |
| 7.5 - 10.0 | 10.30 | 14.18 | 9.0 | 9.68 | 14.84 | 17.0 |
| 10.0 - 15.0 | 14.55 | 9.20 | 20.0 | 17.56 | 11.17 | 20.0 |
| 15.0 - 20.0 | 7.53 | 1.18 | 11.0 | 9.06 | 1.31 | 9.0 |
| 20.0 - 30.0 | 17.88 | 1.63 | 18.0 | 12.25 | .77 | 14.0 |
| (+) 30.0 | 29.30 | 1.02 | 23.0 | 19.26 | .65 | 18.0 |

A cross section of the installation of one of the collectors is shown in Figure 1. There were three different equipment arrangements required for the eight collectors. The equipment configuration was selected to fit the limited space available.

As shown, this collector was installed in the roof and in the flue-gas circuit between the economizer and the air heater. The flue gas was drawn vertically downward through the air heater by the induced draft fan setting on the operating floor.

The induced draft fan required a larger impeller and a larger driving motor to overcome the additional resistance to the gas flow imposed by the collector. The collector hopper extended through the roof where a pneumatic system was installed to remove the fly ash.

The fly ash was conveyed to the basement where it passes through a multiple jet-water ejector. The slurry is then pumped to a fill approximately one-half mile away.

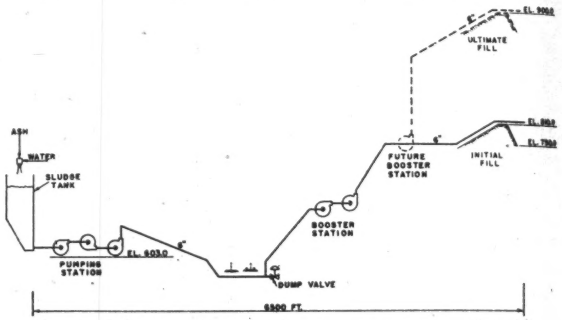



*Fig. 3. Schematic diagram of a sluicing system used in the disposal of fly-ash.*

The disposal area is a low section on the plant property made into a pond by diking with the soil taken from the pond area. It is expected that the pond thus formed will provide a disposal area for the next four years. It will then be necessary to provide other means for disposing of the ash.

While it was not the case in the installation described here, the ash removal and disposal system may represent a very large part of the total investment and become the major operating expense.

In one of the other plants, this item represents an investment of well over a quarter of a million dollars. The operating costs have not been definitely established but ash disposal is inherently a high maintenance cost item.

## Collector Performance Tests

The performance test results of the first collector are shown in Tables II and III. There were tests run on other collectors with essentially the same results. The actual efficiency is expressed in three ways and the expected efficiency is based on the particle size determined from the sample taken at the inlet of the collector.

The particle size analysis is shown in Table III and was determined by the air elutriation method. The technique used in the air elutriation method varies with the user and the results may vary quite widely.

The expected collector efficiency is based on the particle size analysis and therefore, varies with the analysis. It might be well to mention here that the accuracy of particle size

analysis determined by air elutriation for particle sizes below 10 microns is questionable. A standard test code is needed for determining the particle size.

## Dust Particle Size Defined

The ASME Code defines a dust as gas and air borne particles larger than one micron in "mean diameter." Some of the municipal ordinances have defined a dust nuisance as being made up of gas and air borne particles larger than ten microns.

The efficiency of the mechanical collector drops off rapidly as the particle size decreases below ten microns. It is well then to know specifically what is meant by "mean diameter." The particles of fly-ash are certainly seldom regular spheres but comprise a hetrogeneous dust consisting of irregular shapes.

The term "mean diameter" of an irregular shaped particle is assumed primarily to be the diameter of a sphere which would behave the same as the particle under the same circumstances. In sedimentation or elutriation, for example, the principle used is that a particle falling with a certain velocity is assigned a mean diameter which corresponds to the diameter of a sphere that would fall at the given velocity calculated from Stoke's Law.

In the sieving analysis a particle that will just pass through a 325 mesh (Tyler) sieve is assumed to have a diameter of forty-four microns because the apertures are square, averaging forty-four microns on a side.

Irregular-shaped particles will have different behavior characteristics under different circumstances and the analysis by one method will not agree in particle size with that of another method. For instance, a particle shaped like a flat disk may be classed as a large size in the sieving method, but because it settles slowly in sedimentation, it would be classed much smaller in diameter by the latter method.

There is also the danger of reducing the size of the particles by attrition while determining the particle size. The expected or guaranteed collection efficiency of a collector must therefore be based not only on a given particle size distribution, but the method of determining the particle must also be stated. Thus, it can be seen why a standard test code is needed.

*Fig. 4. Route followed by sluicing system shown in Fig. 3.*

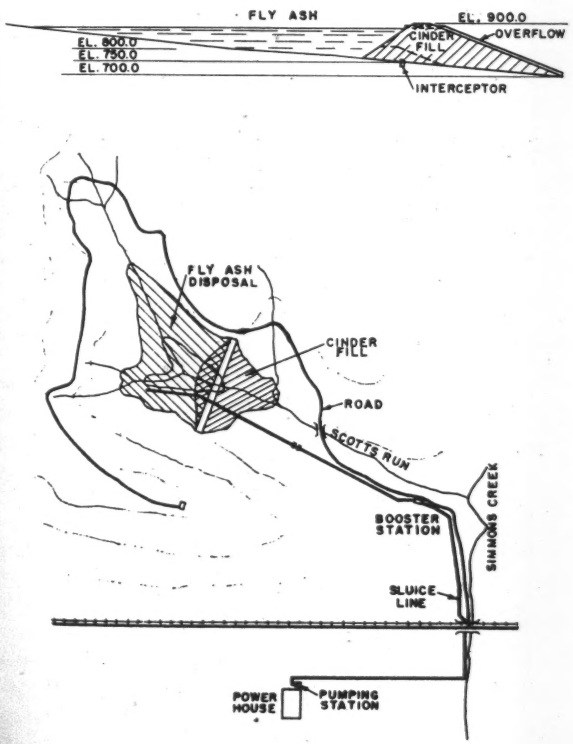



TABLE IV

BOILER OUTLET FLY ASH TEST DATA

FOR

PULVERIZED FUEL, SPREADER AND UNDERFEED STOKER UNITS

| | | Pulverized Fuel Units (1) | | | Spreader Stoker Units (2) | | | Underfeed Stoker Units (3) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | Max. | Min. | Avg. | Max. | Min. | Avg. | Max. | Min. | Avg. |
| Fly Ash Size Distribution | | | | | | | | | | |
| % Less Than 10 Microns | % | 58 | 26 | 41 | 47 | 15 | 28 | 28 | 25 | 26 |
| % Less Than 20 Microns | % | 77 | 48 | 60 | 64 | 20 | 41 | 45 | 43 | 44 |
| % Less Than 40 Microns | % | 98 | 70 | 87 | 78 | 23 | 57 | 63 | 55 | 59 |
| % Less Than 80 Microns | % | 99 | 89 | 97 | 97 | 31 | 69 | 78 | 76 | 78 |
| Boiler Outlet Dust Loading at 500°F. & 50% Excess Air | gr./c.f. | 1.95 | 0.81 | 1.4 | 1.98 | 0.16 | 0.7 | 0.07 | 0.06 | 0.065 |
| Carbon in Fly Ash | % | 36 | 6 | 15.7 | 77 | 42 | 55 | 31 | 24 | 28 |
| Specific Gravity | | 2.5 | 1.9 | 2.1 | 2.2 | 1.9 | 2.0 | 2.4 | 2.3 | 2.35 |
| Spreader Stoker Firing Rate(4) #Coal/Hr/Sq.Ft.of Grate | | - | - | - | 40.5 | 21.4 | - | - | - | - |

Fly Ash Size Distribution and Boiler Outlet Dust Loading

(1) Based on 22 tests

(2) Based on 17 tests

(3) Based on 2 tests

(4) Reinjection from Boiler Hopper Only

## Closing Remarks

Most of the present-day ordinances have been enacted or revised as a result of local studies made following 1946. The need for fly-ash collectors was fully recognized by few industrial plants prior to World War II, but little could be done about it during the war. In a few cases provisions were made for a future installation.

If the collectors are installed when the plant is built, the cost is but a fraction of the cost to install them later, particularly when no provisions are made for the future installation. The mechanical collector has in general been a lower

TABLE V

COMPARISON OF FLY ASH COLLECTOR EFFICIENCIES

| Plant | Type Firing | Inlet Dust Size % Less Than 10 μ | Efficiencies, % Test | Expected |
|---|---|---|---|---|
| A | Spreader Stoker | 23.6 | 92.2 | 93.1 |
| A | Spreader Stoker | 29.3 | 87.6 | 92.0 |
| A | Spreader Stoker | 25.7 | 83.4 | 84.2 |
| B | Pulverized Coal | 43.1 | 87.9 | 86.6 |
| C | Pulverized Coal | 44.7 | 83.6 | 86.4 |
| C | Pulverized Coal | 28.0 | 87.5 | 90.4 |
| C | Pulverized Coal | 40.0 | 86.1 | 86.0 |
| C | Pulverized Coal | 31.0 | 89.3 | 90.0 |
| C | Pulverized Coal | 43.0 | 82.9 | 83.5 |
| D | Pulverized Coal | 47.6 | 67.6 | 77.7 |
| D | Pulverized Coal | 44.9 | 71.3 | 78.9 |
| D | Pulverized Coal | 49.1 | 77.4 | 81.5 |
| D | Pulverized Coal | 51.4 | 77.1 | 80.7 |
| D | Pulverized Coal | 49.1 | 72.3 | 81.5 |
| E | Spreaker Stoker | 15.5 | 90.5 | 88.0 |
| E | Spreaker Stoker | 15.1 | 93.6 | 89.0 |

TABLE VI

COMPARISON OF FLY ASH EMISSION FROM POWER HOUSE STACKS WITH ASME AND APSPAA ORDINANCE LIMITS

| Plant | Stack No. | Steam Load lbs./Hr. | Fly Ash Discharge Actual or Expected Gr./C.F.** | Fly Ash Discharge Actual or Expected Lbs./Hr. | Ordinance Limit APSPAA Lbs/hr | Ordinance Limit ASME Lbs/hr |
|---|---|---|---|---|---|---|
| A | 1 | 80,000 | 0.11 | 45 | 180 | 110 |
| | 2 | 40,000 | 0.11 | 23 | 90 | 55 |
| B | 1 | 350,000 | *0.19 | *430 | 454 | 502 |
| | 2 | 440,000 | *0.19 | *530 | 514 | 630 |
| | 3 | 510,000 | *0.19 | *628 | 558 | 730 |
| | 4 | 350,000 | *0.19 | 430 | 454 | 502 |
| | 5 | 200,000 | 0.19 | 246 | 334 | 287 |
| C | 1 | 470,000 | 0.24 | 605 | 533 | 630 |
| | 2 | 390,000 | 0.24 | 500 | 482 | 520 |
| D | 1 | 140,000 | 0.25 | 162 | 272 | 172 |
| F | 1 | 130,000 | *0.21 | *140 | 260 | 185 |

*Expected

**Corrected to 500°F and 50% Excess Air

cost installation than the electrostatic precipitator and it has been used more widely in the industrial plants.

It does not give the clean up that is possible with the electrostatic precipitator. If the electrical characteristics of the ash are not suitable, the precipitator may also give a performance far below that expected. There seems to be a field for each type. At present, a combination of the two types appears to overcome many of the limitations.

However, cost and space prohibit the use of the combination on most existing boiler plants. The higher efficiency mechanical collectors limit the fly-ash emission rate sufficiently to meet nearly all of the existing ordinances except the A.P.S.P.A.A. ordinance applied to large plants.

It is to be expected that future ordinances will become more restrictive and the improvement in the application of collectors or any other means of reducing atmospheric contamination must be given careful study in considering future installations.

## BOOK BARGAIN!

When Dr. and Mrs. Joseph Vogt, of Pittsburgh, visited Mexico City recently, they found a touch of home in the Mexican metropolis.

Sauntering past the English Book Shop, what should they see prominently displayed in the window but *Air Pollution,* the book reviewed in these columns in August, 1952 issue.

The Vogts forgot to ask how many pesos it would take to buy the book in Mexico. It can, however, be bought for $12.50 in the United States, and APCA members can get it through Association headquarters for only

**$10.63**

The book, under the editorship of Dr. Louis C. McCabe, Chief, Fuels and Explosives Division, U. S. Bureau of Mines, Washington, who is a member of APCA's Board of Directors, contains the 97 interesting papers presented at the U. S. Technical Conference on Air Pollution held in Washington from May 3 to 5, 1950.

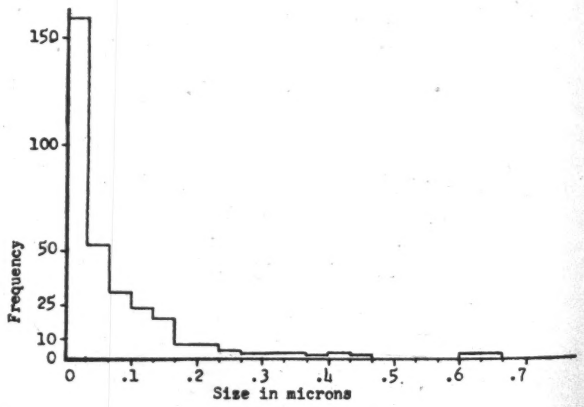
## MUNICIPAL INCINERATOR STACK DISCHARGES

SUMMARY of a paper presented at the annual meeting of the Electron Microscope Society of America, Philadelphia, November, 1951.

Electron micrograph of a thermally precipitated sample at a magnification of 10,000 X. Particle-laden gases collected from the stacks of two municipal incinerators in the Los Angeles area.

Work undertaken by H. Froula, A. Bush, and R. Byloff, Department of Engineering, University of California, as a small part of a more general study of the performance of municipal incinerators.

*Particle Size Distribution for a Typical Count*



# Progress In Air Pollution Control

by W. C. L. HEMEON, *Director of Engineering*
Industrial Hygiene Foundation
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*Presented at the National Planning Conference of the American Society of Planning Officials, Oct. 7, 1952, Boston, Mass. Condensed.*

THE HISTORY of air pollution problems is largely the history of our fuel usage. The accelerated industrial development during the latter part of the 19th Century was accompanied by an enormous increase in coal consumption and a corresponding heightening of the coal smoke nuisance. We can note one early stage in developments toward smoke abatement by the fact of the organization of the Smoke Prevention Association of America in 1905.

The first 25 years of this century were characterized by great progress in the reduction of black smoke from industrial operations. It is difficult for us in 1952 to conceive of the gross inefficiency in coal burning with its dense black smoke in industrial plants that apparently was common 50 years ago. With developing economic pressures for less wasteful burning of coal, together with pressures from city smoke authorities, great strides were made in reduction of smoke from industrial sources.

As progress was made in smoke reduction by large coal users there developed a stage of diminishing returns for the preventive effort expended, characterized by the frustrating problem of abating smoke from the innumerable small users of coal, mainly domestic, which loomed more and more important as smoke from large industrial and commercial sources diminished.

## Fuel Smoke and Fuel Dust

I shall digress briefly at this point to define some terms necessary to a full understanding of this question. Air pollution from coal burning, omitting consideration of sulfur gases for the present, consists in two kinds of solids, firstly the visible *black smoke* that results from ineffective combustion of the volatile gases from coal, and secondly the invisible fuel dust consisting of fine particles of partially coked coal and of ash both lifted from the fuel bed due to the passage of air through the fuel bed.

## Advent of Pulverized Coal

Returning now to the history of smoke abatement activities, one is interested to note the complete preoccupation 25 years ago of most smoke regulation officials with the problem of coal smoke control.

In this system coal is pulverized to a fine powder and blown into the combustion chamber to burn as though it were a gas. The unburned ash (fly ash) composed of extremely fine particles passes out the chimney with the gases to rain out onto the surrounding community. Many old installations are still operating without dust collectors and are responsible for serious pollution of some of our cities.

When we contemplate the magnitude of fly ash nuisance today from such installations it is indeed interesting to note the attitude of some smoke control officials toward this then-new system of coal burning, as brought out by a perusal of the printed proceedings of their conventions 30 to 35 years ago.

It was regarded altogether as an important step forward because it permitted more effective combustion of the coal and more certain elimination of coal smoke and was received with enthusiasm.

So important in the minds of all was the problem of black smoke elimination in those days, and so relatively unimportant the control of dust, that very little attention was given to the potential fly ash nuisance.

We read, for example, in the 1915 proceedings: "(Pulverized coal) has now been adapted to many metallurgical processes with the utmost success and those who have installed this system are the ones most enthusiastic as to its economy, smokelessness and flexibility."

Then we read, in the 1917 proceedings: "The more finely divided the coal is the more readily it can be burned and under proper conditions is *absolutely smokeless*."

The matter of ash dust emission was raised during succeeding discussion, and this answer appears: "Some ash will go out the stack, there is no question about that, but in large installations where the plant is located near the center of town, some method of taking care of that ash may be necessary . . ."

In immediately succeeding years the question of ash discharge recurred but its significance was always minimized.

## Growth of the Fly Ash Problem

As more and more installations were made in the 1920's it soon became apparent that while the black smoke problem from industry had been waning, a new dust nuisance of major proportions had appeared from the pulverized coal development.

Public authorities were not prepared to cope with it; indeed one may say that engineering itself was unprepared. More recently, during the past 15-20 years, the American Society of Mechanical Engineers has devoted some committee activity to the stack dust problem and has published two worthwhile codes or standards relative to it.

## The Domestic Coal Smoke Problem

Returning now to the coal smoke problem two interesting factors operated in the following years, e.g., 1920 to 1940. As previously cited, with increasing accomplishment in smoke abatement among large coal users, the overall rate of accomplishment diminished noticeably. Smoke from domestic coal burning resisted the educational efforts on firing methods that had been successfully applied in industry. At the same time it became clear that homes burning high volatile coal were the one largest remaining source of coal smoke.

## St. Louis and Pittsburgh Laws

St. Louis pioneered a new approach to this problem. After some 40 to 50 years of experience and tribulation, a scheme was evolved under the leadership of Raymond Tucker which culminated in a law enacted in 1940.

Following the same principle we apply to our public water supplies the law controlled at the source the quality of the fuel that could enter the city for sale. High volatile smoky coals were outlawed for delivery to all homes except those equipped with approved stoker devices that could almost automatically burn it without smoke.

New sources of fuel supply were established for St. Louis. A few years later a similar law was enacted in Pittsburgh. The reduction in the coal smoke nuisance was dramatic in both cities. In neither city, however, has the fuel dust problem yet been solved.

## The Allegheny County Development

Three years ago a law was enacted for the County of Allegheny which surrounds the city of Pittsburgh, and it includes similar provisions governing the type of fuel permissible for domestic use.

The provisions of this law affecting industry are noteworthy for the manner of their origin. In a psychologically favorable climate that had been developing over a period of years, the County government, heads of industry and citizens' groups were organized under the leadership of Dr. Edward R. Weidlein, President of Mellon Institute, and

| CENTRAL | Louisville | | Indianapolis | | Kansas City | | Nashville | | Norfolk | |
|---|---|---|---|---|---|---|---|---|---|---|
| HEATING | 1940 | 1950 | 1940 | 1950 | 1940 | 1950 | 1940 | 1950 | 1940 | 1950 |
| Coal | 33,700 | 32,200 | 71,500 | 72,600 | 69,400 | 27,600 | 16,200 | 14,300 | 11,600 | 11,500 |
| Gas | 2,180 | 18,800 | 1,100 | 9,000 | 19,000 | 80,000 | 50 | 3,200 | 80 | 1,600 |
| Oil | 230 | 2,130 | 2,100 | 13,500 | 7,400 | 6,100 | 30 | 240 | 2,900 | 14,000 |
| SPACE HEATING | | | | | | | | | | |
| Coal | 46,400 | 24,400 | 32,500 | 19,800 | 18,000 | 5,000 | 28,500 | 20,300 | 17,800 | 14,900 |
| Gas | 5,300 | 25,300 | 170 | 2,300 | 3,000 | 15,600 | 60 | 6,100 | 70 | 1,400 |
| Oil | 90 | 2,600 | 330 | 8,600 | 530 | 2,300 | 70 | 2,100 | 320 | 8,300 |

matters were brought to a head.

It was agreed that an air pollution ordinance with teeth in it was to be written affecting industry as well as homes. The question to be decided concerned the exact content of the sections affecting industry. A procedure was agreed upon which we think is unique in the annals of ordinance formulation.

Industry itself was to write those regulations concerning industrial stack emissions. They accepted the assignment, studied their problem and phrased the regulation which are now a part of the law that became effective a little over three years ago.

## Railroad Locomotives

There are some other developments that have contributed greatly to the reduction in air pollution throughout the country. One of these has been the large-scale replacement of coal-burning steam locomotives by Diesel engines, a dramatic development that was initiated on a large scale only a few years ago and is still proceeding at a rapid pace (many of you doubtless read of the recent liquidation of the Steam Locomotive Research Institute).

A coal burning locomotive discharges from its stack to the surrounding countryside from 1/6 to 1/2 of all coal charged. Considering the enormous rate of coal consumption in such locomotives it is apparent that this development means a tremendous reduction in fuel dust fall in towns and cities served by railroads.

Illustrating the significance of this Diesel development, during the month of April, 1945, the Pennsylvania Railroad, one of the largest consumers of coal in this country, supplied to its locomotives at Pittsburgh 3,000 carloads of coal.

In April of this year (1952), seven years later, it used only 345 carloads. In a word, almost 90 percent of its former coal consumption has been eliminated by the Diesel engine replacement program. This, it will be noted, has been a change dictated by technological development, not by social regulation.

## Trends in Domestic Fuel

Another development of far-reaching importance has been the extension in use of natural gas for home heating (as well as for industrial purposes) brought about by the network of long distance pipe lines from the gas fields of Texas, and also in extension of the use of oil.

By comparison of census figures for 1940 and 1950 for some of the cities in the soft coal burning areas, the following changes in units of domestic fuel character appear:

They show large reductions in all those cities in the *percentage* of all heating units using coal which in those regions means soft coal. Now as it happens the figures for central heating in Louisville, Indianapolis, Nashville and Norfolk show no important decrease in the actual numbers of heating units using coal.

The *increase* in housing units (i.e., population) is paralleled by a corresponding increase in gas or oil and this accounts for the reduced percentage using coal.

In Kansas City, the domestic coal consumption was more than halved and the use of gas quadrupled. In other words, with an increase in population the use of soft coal has either remained stationary or decreased so while these figures in themselves may indicate no net decrease in coal smoke from domestic sources in some cities, they show clearly that profound changes are occurring in the fuel consuming characteristics of the country, which if continued can be expected eventually to solve some of the smoke problems of such cities.

## Other Changes in Fuel

The large-scale development of district heating plants in our large cities has very greatly simplified and aided their smoke and fuel dust control problem. The invasion of the industrial fuel market along the eastern seaboard by petroleum fuel, a market formerly held exclusively by bituminous coal, has resulted in important reductions in fuel dust in those cities, although it may introduce a different air pollution quality as suggested by our recently completed survey for the City of New Haven. Finally, no list of changes of the past 30 to 40 years would be complete without at least mention of the road dust reduction that has accompanied the enormous road paving development that paralleled the rise of the motor car.

## Invisible Dust Emissions

The dust nuisance of modern cities is quite a different problem. The fuel stack dust emissions are not visible, yet there still are visible fuel smoke emissions from other stacks and there is no connection between the two. The significance of this is far reaching. The non-technical public is no longer qualified to judge the relative importance of visible emissions as they are still doing in cities throughout the country. Indeed, smoke control officials themselves can no longer operate on the basis of visible smoke emissions.

## Basis of Demands for Cleaner Air

What is the significance of the fact that citizens everywhere are demanding increased and more effective prosecution in the field of air pollution abatement—this in the face of the tremendous advances of the past three or four decades: reduction in road dust and coal smoke, the passing of the steam locomotive, the evolution in domestic heating toward smokeless fuels, the switch in some areas from bituminous coal to petroleum fuel, and the improvements that have resulted from supersedure of numerous smoke-making heating plants by the large well controlled district heating plants.

This is an important question because a sound answer to it will serve as a valuable formula on which to plan future measures in this field of activity. First, it seems quite probable that the demand for more effective air pollution control is basically a logical development parallel to the advancing standards of living that has characterized the maturing of this country, and even more important the growing conviction by people that smoke and dust is unnecessary and readily corrected (an opinion that is frequently well founded).

The evidence of the past we believe also supports our thesis that it is not so much the amount of improvement effected, but the rate of that improvement over a period of years, that determines in large measure the attitude of people in its judgment concerning the existence or not of an air pollution nuisance.

## Need for Technical Investigation

If one accepts that thesis, we think it follows that one essential to a sound program is a schedule of continuing measurements that *are* significant and do properly reflect the intensity of air pollution in any year, and the improvements. It must be stated that, unfortunately, very few cities are engaged in any program of measurement and fewer still in an adequate one.

Another conclusion we think should be drawn from the facts concerning visible and invisible emissions, for application to the design of a future program of air pollution control is that little can be accomplished usefully until the nature of the air pollution problem of a community has been adequately defined.

We mean that the definition should be based on a painstaking technical study which develops—from proper measurements and supplemental observations—a quantitative description of the kinds of dust and other air pollutants, their source and relative amount.

## Stack Dust Emission Specifications

The standards of performance to be required in the cleaning of stack gases before discharge to the atmosphere of the community is partly, though not entirely, an engineering question. The significance of this statement is well set forth in the foreword to the model smoke law of the ASME, which we quote in part, as follows:

". . . All differences of opinion and all controversy relative to a smoke ordinance are basically economic . . . It can be assumed that no one desires unclean air: the question is, how clean an air can the community afford? Engineering can provide it. (Many schemes involving, for example, centralization of fuel facilities) are not ordinarily considered because of the cost. What is considered is some economic compromise." Those words clearly express the relative role of the engineer and of the planner in the selection of specifications for atmospheric purity.

It is a well-established principle that the air pollution regulations of one community may not be properly applicable at all to another. We think it consistent with that principle to suggest that not only should higher performance standards in the cleaning of industrial stack gases be required on all new construction, but even more stringent ones should apply to new industrial installations in inhabited areas that were previously non-industrial.

Little or no hardship to industry is involved when specifications are fixed at the time the new plant is being designed. Difficulties often arise in those cases where a suppression device is required after the plant is in operation.

## Health and Nuisance Aspects

Some comment is in order here on the controversial health aspect of the air pollution question. Arguments concerning adverse effects on health are usually advanced as a part of citizens' campaigns for improvements in air pollution control.

The fact is that any claims can be based on no more than inference since there are no objective data in existence demonstrating either that there is, or is not, a deleterious effect on health. But this only beclouds the issue because there is no necessity for proving effects on health to justify measures for cleaner living environment. The people of a community have the right to demand such improvements as are consistent with practical solutions.

## Legislative Aspects

A useful perspective in planning for the future in this field is provided by noting how relatively ineffective some of our air pollution control laws have been in the past when compared, in terms of accomplishment, with a vast, technological movement such as the elimination of the steam locomotive which in a short decade will have dramatically modified the character of living along railroad rights-of-way throughout the country.

Moreover, experience of the past has repeatedly demonstrated that the mere passage of legislation on forbidding certain air polluting practices does not in itself solve air pollution problems.

Nor, contrary to the views commonly held by citizens and respected newspapers in certain localities, such problems are not solved by the wielding of a big stick and dramatic attacks on visible smoke emissions.

This raises an important question of public relations for the air pollution control agency. An aggressive administration of control ordinances with frequent recourse to courts of law has great appeal to the public and public approval is important to an effective administration.

Can one expect adequate public support for the undramatic, sober, technical effort required to establish firm foundations? In our opinion the answer would be affirmative, that all the public desires, (and is entitled to), is a basis for conviction that its agency knows what it is doing, where it is going, and is making satisfactory progress toward its goal of improvement.

# The Role of Industry in Air Pollution

by Walter C. Wagner, *Staff Engineer,*
Executive Department, Philadelphia Electric Company,
Philadelphia

*Presented at the annual health conference of the Pennsylvania Department of Health, Harrisburg, Pa., Aug. 25-28, 1952. Condensed.*

OVER THE YEARS the State of Pennsylvania has been recognized as the great center of industrial activity in this nation, with respect to the importance of its manufactured products, their diversity, and the quantities of production.

While ostensibly representing all industry, I must hasten to explain that I have not made as many informal contacts with various individual organizations within our state as I would have liked. But I have found that every person contacted was earnestly concerned about his industry's participation. All agreed they were truly pioneering in these days and that close and understanding teamwork with the regulatory bodies was absolutely necessary for the best interests of all concerned.

What sheds a new light is that our industries' employees, their families and associates, comprise the bulk of the population, and therefore we are directly concerned with the health, welfare and comfort of all the state's population.

The brilliant history of effective collaboration between our industries is being recognized nationally and internationally. Through such intimate and effective teamwork, The Department has not only secured an adequate degree of protection, but the Department's experience and guidance also have contributed materially to the successes of similar regulatory bodies in other states.

History is now repeating itself, presenting the problem of developing controls for outer atmospheric pollution affecting the public. While, in general, industries in the past have recognized their responsibilities to the public as a whole, and have made use of the best available means to diminish the flow of pollutants from their stacks materially affecting the public, it is only recently that this has been more actively considered a subject of legislative and administrative action.

We are particularly fortunate. First, the teamwork over the years between the Department of Health and our individually established industries, has given that department an intimate knowledge of the conditions existing in each manufacturing activity in most of the industries involved.

Second, with this knowledge of industry's operating conditions and with well-considered state, city, and county enactments implemented by seasoned directors, our industries feel assured that they are successfully pioneering in this comparatively new field of responsibility.

## Use Best Materials

When added or new manufacturing facilities that may cause objectionable emissions are being installed, the most recently developed and proved equipment and methods of operation are given consideration to assure the use of the best practicable means of air pollution control.

Such has been the degree of understanding that not only have existing industries been more than willing to endeavor to meet these responsibilities to the extent of their ability, but such action provided incentives for new industries to locate in our increasingly important commonwealth.

Similar summations of like experiences throughout our nation, slowly but surely acquired by individual industries and national organizations of the industries directly and indirectly concerned and all effectively collaborating with their regulatory bodies and others, shall serve gradually but with certainty to bring about the national adoption of the best and most effective controls.

Industry is growing increasingly interdependent in meeting the demands of both national and international trade. Foreign nations with industries have for some time been actively

preparing to win increasing world-wide commercial advantages.

Factories are going up, employees are being readied for work. Air pollution within and outside those foreign factories appears to be of minor concern to their workers, merchants, and population generally; all of whom are looking eagerly forward to active production and shipments of their products abroad.

For us to meet this very real and growing challenge, and to hold our proper place in the sun, improved equipment and methods of operation and improved health and welfare of our workers and of the public shall, in combination, adequately serve in no small measure. Investigation, research, balanced development and close collaboration between industry, commerce, and our regulatory bodies, together with effective applications of related and sound relations are, of course, required.

## Basic Policies

The industries of our state are intimately concerned and certain basic policies have become established in regard to the subject. Our industries believe as follows:

1. We should make every practicable effort to reduce emissions from existing plants of gases, vapors and solids that are definitely recognized as appreciably affecting public health and welfare.
2. We should take full advantage of economic advances to the limits of practicability in the design and operation of the best existing forms of equipment and air pollution controls when installing additions to existing facilities or constructing new installations.
3. When considering the location of a new installation, to learn from state and other authorities all the characteristics of the location with respect to their influence upon our air pollution control problems.
4. Leave nothing undone in the proper selection of the materials used in processes, and the training of operators who directly or indirectly determine the extent and characteristics of such objectionable emissions.
5. Periodically check the concentrations of the elements from each source of emission, and by such comparisons maintain an integrity of operation.
6. Intimately concern ourselves with other industrial and civic activities related to our own emission control problems. By this means a better general understanding with the public and with representatives of air pollution control bodies will be mutually beneficial.
7. Actively participate in all such air pollution control. In some instances our own industries' national associations may be of material assistance because of their knowledge of actions and their experience with other applications of enactments introduced throughout the nation. It is recognized that, in general, specific problems are essentially local in character, and that a positive disservice may result in immaturely considered proposals for general control through the non-recognition (ignorant or otherwise) of the nature and extent of the problems involved.

   When participating in such deliberations it should be realized that the average American public's reaction to a problem affecting them is—"there ought to be a law." Possibly some laws may already exist that can meet the situations.

   If not, then we must participate to the extent that a good guide shall be enacted; one that will accomplish its purpose for the public and the industries most effectively without being unfairly or unnecessarily restrictive.
8. We must obtain men of proven technical ability and administrative capacity to assure the continued application of such regulations in an understanding and far-seeing manner.

   And where no specific guidance exists, to use sound and unbiased judgment in determining the proper balance between seriousness of the effects and expenditures of time, money, and possible introductions of handicaps to the industries involved.

   *In these days of keen competition between materials, equipment and processes, it is vitally necessary to have key men in regulatory bodies whose abilities are outstanding and whose judgment is unquestioned.*

   There are many men of this calibre giving such direction today. Industry would suggest that legislative bodies provide sufficient financial incentives that will attract desirable men and women to fill the rapidly expanding needs for such direction.

   A full knowledge of every form of industrial activity is not necessarily required or expected of those applying such regulations. The proposals for means to attain results and the costs involved are generally the responsibilities of the individual industries. Applications of regulations should be based on agreements between those in individual industries and those responsible for carrying out the related rules.

   In this way all questions concerning the character of the activities, the limitations of capacity and performance, of the nature of the facilities and their maintenance, of growth, of the problem of availability of trained personnel, and consideration of all other related economic, physical, and technical influences entering into each problem, can be thoroughly understood. There rests upon the shoulders of such persons the responsibilities for proper evaluation of conditions and the determination of their remedies, to the end that American industry shall best serve our people as a whole.
9. As means to best meet the problems arising from the pollution in the atmosphere, the need for national standardization becomes more pronounced. National standards for air pollution control developed by and for the use of those substantially concerned shall surely be formulated. And periodic revisions must be made continually to best serve industrial progress.

The Air Pollution Control Association, of the United States and Canada, of which the Pennsylvania Department of Health is a member, has a program under way including the entire scope of air pollution control. Many of the industries of our state or their national organizations who are not as yet members of the Air Pollution Control Association are finding it increasingly to their material advantage to become active members. By this means the best possible collective effort on the part of the representatives of industries and air pollution control bodies can be assured.

10. We in Pennsylvania realize our increasing responsibilities for even greater efforts to limit the concentrations of emissions measurably affecting the health and welfare of all our citizens.

While evaluations of the destructive effects of dirt and dust deposits on surfaces have been measurable to some degree, the medical problems concerning the allowable percentage of concentrations to properly conserve the health of our people are infinitely more difficult to cope with as compared with those which we have so successfully solved in the operations of industrial hygiene.

This applies with equal force to the effects upon animal and plant life. Such effects must, to the greatest possible degree, be as measurable as those of the causes if full justice is to be achieved for all concerned.



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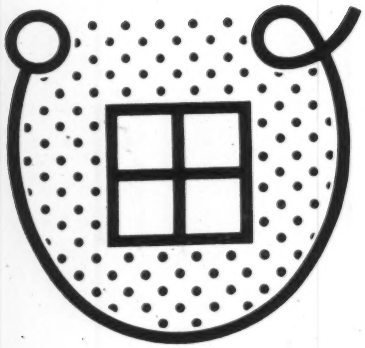

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